Personalized Nutrition through 3D Food Printing: Field Research from Low Income and Elderly Communities in India

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Abstract

Malnutrition continues to affect millions of children and elderly individuals in India, especially in low-income urban areas. Government schemes such as ICDS and the Mid-Day Meal program have made progress, yet widespread nutritional gaps remain due to poverty, limited awareness, and lack of appealing, healthy food options. This research, conducted in eight South Delhi slums and three elderly homes, explores the potential of 3D food printing as a transformative solution. By enabling customization of meals based on age, dietary needs, and texture preferences, 3D food printing can deliver affordable, nutritious alternatives to junk food for children and soft, easy-to-digest meals for the elderly. Our findings suggest that with proper policy support and community adoption, 3D food printing could help bridge India's nutrition deficit and advance progress toward the Sustainable Development Goal of Zero Hunger.

Introduction + Literature Review

India's malnutrition challenge is among the most severe in the world, with nearly half of children in the lowest income quintile stunted or underweight. Elderly populations face similar risks, often skipping meals due to chewing difficulties, repetitive food textures, or pill fatigue. While government nutrition programs address part of this problem, gaps in coverage, quality, and community acceptance persist.

Literature on 3D food printing highlights its promise in creating nutrient-dense, customized meals. Studies in Germany and Switzerland have shown how texture-modified foods benefit elderly patients with dysphagia, while research in India has experimented with millet- and lentil-based printed snacks. Baiano (2022) and Chao et al. (2024) emphasize the ability of 3D printing to incorporate diverse ingredients—including fruits, vegetables, and legumes—while maintaining texture and palatability. Despite these advances, India lacks large-scale adoption or pilot studies in vulnerable communities, leaving unexplored potential for innovation.

Research Methodology + Observations

- To assess both nutritional needs and the feasibility of 3D food printing
  interventions, we conducted fieldwork across eight slum communities and three old age homes in South Delhi. The study involved 300 children aged 4–14 and 60
  elderly residents, using structured interviews, surveys, and observational methods.

- Among children, junk foods such as instant noodles, chips, and street snacks dominated diets. This reliance on calorie-dense but nutrient-poor foods led to
  noticeable cognitive sluggishness, stunted growth, and increased dropout rates. Parents often lacked nutritional awareness, and affordable, healthy alternatives were scarce.

- For the elderly, monotony in meals, chewing and swallowing difficulties
  (dysphagia), and avoidance of supplements were common. Many skipped meals
  altogether, compounding nutritional deficiencies. These findings underscored the need for tailored interventions that provide both nutritional density and sensory appeal.

Below is a visual representation of the percentage of affected individuals based on our research

Findings from Field Research: South Delhi (2025)
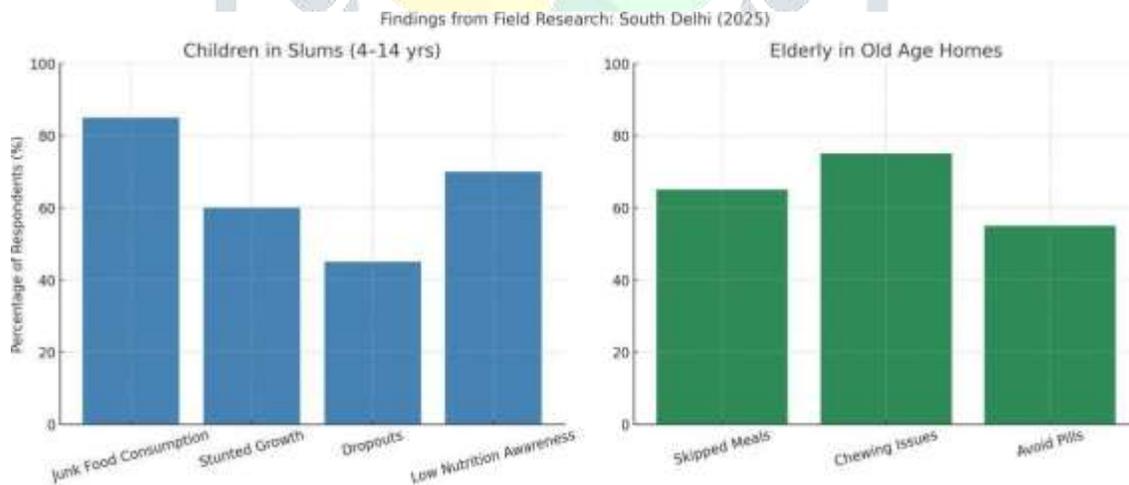
- • **Left Chart**: Shows major issues among children aged 4–14 in South Delhi slums (high junk food consumption, stunting, school dropouts, and low
    parental nutrition awareness).
- • **Right Chart**: Captures challenges faced by elderly residents in old age homes (meal skipping, chewing issues, and avoidance of medication due to
    drowsiness).

Implementation of 3D Food Printing (3DFP)

3D food printing offers a way to translate these needs into practice. For children, nutrient-rich snacks such as ragi-amaranth cookies or flaxseed-oats patties can be
printed in engaging shapes—stars, letters, or animals—that rival the visual appeal of junk food. For elderly populations, soft-textured lentil-based fritters, puddings, or fortified laddoos can ease digestion and improve compliance without sacrificing flavor.

Global precedents support this potential: Germany's PERFORMANCE project has implemented 3D "smoothfood" in elderly care homes, while Swiss and UK

researchers have developed printed meals for pediatric and geriatric care. In India, however, adoption is hindered by low awareness, high costs, and lack of pilot

integration into government schemes.

To scale implementation, partnerships are essential. Equipping schools, anganwadis, and elderly homes with basic printers under CSR or state programs, sourcing

ingredients locally, and running taste-acceptance trials could catalyze adoption.

Moreover, linking outputs with existing initiatives like the Mid-Day Meal Scheme and ICDS would align innovation with public nutrition delivery.

Conclusion

3DFP is a practical, scalable technology capable of addressing India's malnutrition crisis. By providing customized, affordable, and appealing meals, it can bridge

nutritional gaps for vulnerable populations. With government backing, private-sector investment, and community engagement, this innovation could become a

cornerstone in India's and the global community's fight against malnutrition.

The image presents two comparative tables outlining nutritional challenges faced by children (ages 4–14) and elderly individuals, alongside proposed 3D food printing solutions and recommended ingredients:

For Children (Ages 4-14)

Challenge	3D Printing Solution	Recommended Ingredients
Low attention spans, stunting, frequent illness	Nutrient-packed, fun-shaped snacks (stars, animals, letters) to encourage consumption	Ragi, amaranth, jaggery, roasted peanuts, fortified rice powder, Bengal gram, banana flour
Preference for junk food like Kurkure, Maggi	Crunchy-yet-healthy snacks mimicking chips or noodles	Beetroot & carrot flour, millets, turmeric, sweet potato, lentils
Iron, calcium, and protein deficiency	Fortified soft bars or cookies	Iron-fortified wheat, dates, sesame seeds, soy flour, flaxseed
Skipping meals due to unattractive food	Edible cartoon-shaped pancakes and fritters	Spinach, pumpkin, oats, methi, basil, coconut flour, honey

For the Elderly

Challenge	3D Printing Solution	Recommended Ingredients
Chewing/swallowing difficulty (dysphagia)	Soft, pudding-textured foods in familiar forms (e.g., dal, idli, sabzi)	Moong dal, urad dal paste, mashed peas, yogurt, mashed cauliflower
Lack of appetite or repetitive textures	Variety in texture, aroma, and colors to stimulate interest	Coriander, ginger, curry leaves, tomato pulp, barley flour
Avoidance of pills & supplements	Vitamin- and mineral-enriched cookies, laddoos, or chews	Ragi, amla, ghee, turmeric, chia seeds, almonds (in paste form)
Digestive issues	Easily digestible snacks with fiber and probiotics	Oats, isabgol husk, curd-based batters, fermented rice/lentil batters

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